

IT IS CLAIMED:

1. A method for synchronizing time reference devices in an access network, the access network comprising a Head End and a plurality of nodes, the Head End including an access control system having a plurality of media access controllers, each media access controller controlling a respective interface to the access network, the plurality of media access controllers including a first distinct access controller for controlling a first interface, said first access controller including a first time reference device, said first interface including a first distinct plurality of ports for communicating with at least a first portion of the plurality of nodes, the plurality of access controllers further including a second distinct access controller for controlling a second interface, said second access controller including a second time reference device, said second interface including a second distinct plurality of ports for communicating with at least a second portion of the plurality of nodes, the method comprising:

providing at least one synchronization signal to said first and second access controllers; and

utilizing, at said first and second access controllers, said at least one synchronization signal in a manner which results in the first and second time reference devices being in synchronization with each other.

2. The method of claim 1 wherein said first access controller and said first interface reside on a first physical line card within the access control system, and the second access controller and second interface reside on a second physical line card within the access control system.

3. The method of claim 1 wherein said access network is a wireless network.

4. The method of claim 1 wherein said access network is a cable network, said plurality of nodes are cable modems, and wherein said access control system is a Cable Modem Termination System (CMTS).

5. The method of claim 4 wherein said first and second access controllers are Media Access Control (MAC) devices residing on different physical line cards within the CMTS, said first and second access controllers being configured or designed to operate in accordance with a DOCSIS standard.

6. The method of claim 1 further including generating at least one synchronization signal from a synchronization device, said synchronization signal including time reference data to be used to synchronize each of the plurality of access controllers in the access control system.

7. The method of claim 1 wherein the synchronization signal is provided at periodic intervals to the first and second access controllers.

8. The method of claim 2 wherein said first plurality of ports includes a first downstream channel transmitter and at least one first upstream channel receiver, and wherein the second plurality of ports includes a second downstream channel transmitter and at least one second upstream channel receiver, said method further comprising:

providing a first time reference message to a first node on said first downstream channel, said first time reference being generated by said first time reference device; and

receiving data from said first node at said Head End via said second upstream channel.

9. The method of claim 8 further comprising using said first time reference message to synchronize a time reference device within said first node with said first time reference device.

10. The method of claim 1 further including:  
providing time reference data to each of the plurality of access controllers; and

simultaneously loading, at each of the plurality of access controllers, said time reference data into its respective time reference device to thereby cause each of the time reference devices to be synchronized with each other.

5 11. The method of claim 10 further comprising:

asserting a DATA\_VALID signal to each access controller to thereby cause each access controller to load said time reference data within an internal memory device; and

de-asserting said DATA\_VALID signal to thereby cause each access controller to stop loading data into the internal memory device.

10

12. The method of claim 11 wherein said loading includes simultaneously providing a LOAD\_DATA signal to each access controller to thereby cause each access controller to simultaneously load the time reference data from its internal memory device into its time reference device.

15

13. The method of claim 11 wherein said loading includes each access controller automatically loading the time reference data from its internal memory device into its time reference device at a predefined time after said DATA\_VALID signal has been de-asserted.

20

14. The method of claim 2 further comprising providing time reference synchronization messages from the Head End to the plurality of network nodes.

25

15. The method of claim 14 wherein a first plurality of network nodes belong to a first DOCSIS domain, and a second plurality of network nodes belong to a second DOCSIS domain.

16. A method of configuring an access network, the access network comprising a Head End and a plurality of nodes, the Head End including an access control system

having a plurality of media access controllers, each of the plurality of media access controllers controlling a respective interface to the access network, each of the plurality of media access controllers including a distinct time reference device, each interface including a distinct plurality of ports for communicating with at least a portion of the plurality of nodes, the method comprising:

synchronizing the time reference devices in each of the plurality of access controllers; and

assigning selected ports from the plurality of interfaces to particular domains within the access network.

17. The method of claim 16 wherein said assigning includes assigning at least one port from a first interface to a first domain, and assigning at least one port from a second interface to said first domain.

18. The method of claim 17 wherein said access network is a cable network, said plurality of nodes are cable modems, and wherein said access control system is a Cable Modem Termination System (CMTS).

19. The method of claim 18 wherein said first and second domains are different DOCSIS domains.

20. The method of claim 17 wherein said first interface resides on a first physical line card within the access control system, and the second interface resides on a second physical line card within the access control system.

21. The method of claim 17 wherein said first domain includes at least two downstream channels.

22. The method of claim 17 wherein said first domain includes a first plurality of ports, said first plurality of ports including at least two downstream channel transmitters.

23. A method for synchronizing nodes in an access network to a common time reference, the access network comprising a Head End and a plurality of nodes, the Head End including an access control system having a plurality of media access controllers, each of the plurality of media access controllers controlling a respective interface to the access network, each of the plurality of media access controllers including a distinct time reference device, each interface including a distinct plurality of ports for communicating with at least a portion of the plurality of nodes, the method comprising:

providing a first time reference message to a first node via a first downstream channel, the first downstream channel being associated with a first media access controller and a first interface, the first time reference message being generated from a first time reference device associated with the first media access controller;

providing a second time reference message to a second node via a second downstream channel, the second downstream channel being associated with a second media access controller and a second interface, the second time reference message being generated from a second time reference device associated with the second media access controller, wherein said first and second time reference devices are synchronized with each other; and

synchronizing said first and second nodes by using said first time reference message to synchronize a time reference device of said first node with said first time reference device, and using said second time reference message to synchronize a second time reference device of said second node with said second time reference device.

24. The method of claim 23 wherein said first access controller and said first interface reside on a first physical line card within the access control system, and the second access controller and second interface reside on a second physical line card within the access control system.

25. The method of claim 23 wherein said access network is a cable network, said plurality of nodes are cable modems, and wherein said access control system is a Cable Modem Termination System (CMTS).

26. The method of claim 25 wherein said first and second access controllers are Media Access Control (MAC) devices residing on different physical line cards within the CMTS, said first and second access controllers being configured or designed to operate in accordance with a DOCSIS standard.

5

27. The method of claim 26 wherein said first node is a cable modem belonging to a first DOCSIS domain, and said second node is a cable modem belonging to a second DOCSIS domain.

10

28. The method of claim 26 wherein said first and second nodes are cable modems belonging to a first DOCSIS domain.

29. A Head End of an access network, the access network comprising a plurality of nodes, the Head End comprising:

15

a master time reference device which maintains and updates a current time reference;

a plurality of physically distinct network interfaces to the access network, each network interface comprising:

20

a group of distinct ports to nodes on the access network; and  
a slave time reference device in communication with the master time reference device, thereby allowing each network interface to obtain the current time reference at the same time so that the plurality of network interfaces are in synchronization.

25

30. The Head End of claim 29 wherein said access network is a cable network, said plurality of nodes are cable modems, and wherein said Head End is a Cable Modem Termination System (CMTS).

30

31. The Head End of claim 29 further including a back-up time reference device for maintaining and updating the current time reference, and for providing the

current time reference to each of the slave time reference devices at times when a failure is detected at the master time reference device.

5 32. The Head End of claims 29 wherein the plurality of network interfaces includes a first network interface residing on a first physical line card, and includes a second network interface residing on a second physical line card.

33. A Head End of an access network, the access network comprising a plurality of nodes, the Head End comprising:

10 a master time reference device which maintains and updates a current time reference; and

a plurality of slave media access controllers in communication with the master time reference device, each of said slave media access controllers being responsive to control signals from the master time reference device to use the current time reference to  
15 synchronize itself with other slave media access controllers in the Head End.

34. The Head End of claim 33 wherein each of the plurality of slave media access controllers includes a respective slave time reference device; and wherein

20 each of said slave media access controllers is responsive to control signals from the master time reference device to use the current time reference to synchronize its respective slave time reference device with other slave time reference devices in the Head End.

35. The Head End of claim 33 further including a master media access controller which includes the master time reference device.

25

36. The Head End of claim 33 wherein each of the plurality of slave media access controllers controls a respective interface to the access network, each network interface including a distinct plurality of ports for communicating with at least a portion of

the plurality of nodes, and wherein the plurality of network interfaces are in synchronization with each other.

5 37. The Head End of claim 36 wherein the plurality of network interfaces includes a first portion of interfaces which each include at least one downstream channel for providing video content.

38. The Head End of claim 33 wherein said access network is a wireless network.

10 39. The Head End of claim 33 wherein said access network is a cable network, said plurality of nodes are cable modems, and wherein said Head End is a Cable Modem Termination System (CMTS).

15 40. The Head End of claim 33 further including a back-up master time reference device for maintaining and updating the current time reference, and for providing the current time reference to each of the slave media access controllers at times when a failure is detected at the master time reference device.

20 41. The Head End of claim 40 wherein the back-up master time reference device is configured as part of a slave media access controller.

25 42. The Head End of claim 36 wherein a first media access controller and a respective first interface reside on a first physical line card, and wherein a second media access controller and a second respective interface reside on a second physical line card.

43. The Head End of claim 42 wherein said first interface includes a first plurality of ports, and wherein said first plurality of ports includes a first downstream channel transmitter and a second downstream channel transmitter.



44. The Head End of claim 43 wherein a first downstream channel corresponding to the first downstream channel transmitter is assigned to a first domain, and a second downstream channel corresponding to the second downstream channel transmitter is assigned to a second domain.

5

45. The Head End of claim 42 wherein said first interface includes a first plurality of ports, said first plurality of ports including at least one first downstream channel transmitter;

wherein said second interface includes a second plurality of ports, said second plurality of ports including at least one second downstream channel transmitter;

wherein said first downstream channel transmitter is configured to provide a first time reference message to a first portion of the network nodes;

wherein said second downstream channel transmitter is configured to provide a second time reference message to a second portion of the network nodes; and

wherein said first and second time reference messages are derived from different media access controllers which are in synchronization.

46. The Head End of claim 45 wherein the first and second plurality of ports each belong to a same domain.

47. The Head End of claim 45 wherein the first and second plurality of ports each belong to a different domain.

48. The Head End of claim 33 wherein said master time reference device includes:

a DATA\_VALID output line for indicating transmission of valid data to each slave media access controller; and

a DATA output line for providing data to each slave media access controller; and

49. The Head End of claim 48 wherein said master time reference device further includes a LOAD\_DATA output line for simultaneously signaling each slave media access controller to load the data provided on said DATA line.

5 50. The Head End of claim 48 wherein each slave media access controller further includes:

a DATA\_VALID input line for receiving a DATA\_VALID signal from the master time reference device; and

a DATA input line for receiving data from the master time reference device.

10 51. The Head End of claim 50 wherein each slave media access controller further includes a holding register for storing time reference data received from the master time reference device.

15 52. The Head End of claim 50 wherein each access controller is configured or designed to load time reference data received on said data input line into said holding register, and is further designed or configured to load said time reference data from the holding register into the slave time reference device upon an occurrence of an event.

20 53. The Head End of claim 52 wherein said master time reference device further includes a LOAD\_DATA output line, each slave media access controller includes a LOAD\_DATA input line, and wherein said event is an assertion of a DATA\_LOAD signal at said master time reference device.

25 54. The Head End of claim 52 wherein said event is a de-assertion of a DATA\_VALID signal at said master time reference device.

55. The Head End of claim 40, wherein said master time reference device further includes at least one output status line for communicating an operating status of the master time reference device to the back-up master time reference device.

5 56. The Head End of claim 34 wherein said master time reference device and each of said slave time reference devices is a timestamp counter.

10 57. The Head End of claim 33 wherein said Head End further includes a clock signal derived from a network source, said Head End being configured or designed to provide the clock signal the master time reference device and each of the slave media access controllers.

15 58. The Head End of claims 57 wherein said network source is a stratum clock source.

20 59. A computer program product for synchronizing interfaces of an access network, the access network comprising a Head End and a plurality of nodes, the Head End including an access control system having a plurality of slave media access controllers, each slave media access controller controlling a respective interface to the access network, the plurality of slave media access controllers including a first distinct access controller for controlling a first interface, said first access controller including a first time reference device, said first interface including a first distinct plurality of ports for communicating with at least a first portion of the plurality of nodes, the plurality of access controllers further including a second distinct access controller for controlling a second interface, said second access controller including a second time reference device, said second interface including a second distinct plurality of ports for communicating with at least a second portion of the plurality of nodes, the computer program product comprising:

25 a computer usable medium having computer readable code embodied therein, the computer readable code comprising:

30 computer code for providing at least one synchronization signal to said first and second access controllers; and

computer code for utilizing, at said first and second access controllers, said at least one synchronization signal in a manner which results in the first and second time reference devices being in synchronization with each other.

5           60.    The computer program product of claim 59 wherein said access network is a cable network, said plurality of nodes are cable modems, and wherein said access control system is a Cable Modem Termination System (CMTS).

10           61.    The computer program product of claim 59 further including:  
computer code for providing time reference data to each of the plurality of access controllers; and

computer code for loading, at each of the plurality of access controllers, said time reference data into its respective time reference device to thereby cause each of the time reference devices to be synchronized with each other.

15           62.    A computer program product of configuring an access network, the access network comprising a Head End and a plurality of nodes, the Head End including an access control system having a plurality of slave media access controllers, each of the plurality of slave media access controllers controlling a respective interface to the access  
20 network, each of the plurality of slave media access controllers including a distinct time reference device, each interface including a plurality of distinct ports for communicating with at least a portion of the plurality of nodes, the computer program product comprising a computer usable medium having computer readable code embodied therein, the computer readable code comprising:

25           computer code for synchronizing the time reference devices in each of the plurality of access controllers; and

computer code for assigning selected ports from the plurality of interfaces to particular domains within the access network.

30           63.    The computer program product of claim 62 wherein said assigning code includes computer code for assigning at least one port from a first interface to a first

domain, and computer code for assigning at least one port from a second interface to said first domain.

64. The computer program product of claim 63 wherein said access network is a cable network, said plurality of nodes are cable modems, and wherein said access control system is a Cable Modem Termination System (CMTS).

65. A computer program product for synchronizing nodes in an access network to a common time reference, the access network comprising a Head End and a plurality of nodes, the Head End including an access control system having a plurality of slave media access controllers, each of the plurality of slave media access controllers controlling a respective interface to the access network, each of the plurality of slave media access controllers including a distinct time reference device, each interface including a plurality of distinct ports for communicating with at least a portion of the plurality of nodes, the computer program product comprising:

a computer usable medium having computer readable code embodied therein, the computer readable code comprising:

computer code for providing a first time reference message to a first node via a first downstream channel, the first downstream channel being associated with a first slave media access controller and a first interface, the first time reference message being generated from a first time reference device associated with the first slave media access controller;

computer code for providing a second time reference message to a second node via a second downstream channel, the second downstream channel being associated with a second slave media access controller and a second interface, the second time reference message being generated from a second time reference device associated with the second slave media access controller, wherein said first and second time reference devices are synchronized with each other; and

computer code for synchronizing said first and second nodes by using said first time reference message to synchronize a time reference device of said first node with said first time reference device, and using said second time reference

message to synchronize a second time reference device of said second node with said second time reference device.

- 5 66. The computer program product of claim 65 wherein said access network is a cable network, said plurality of nodes are cable modems, and wherein said access control system is a Cable Modem Termination System (CMTS).